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System Requirements

NetLogo is designed:

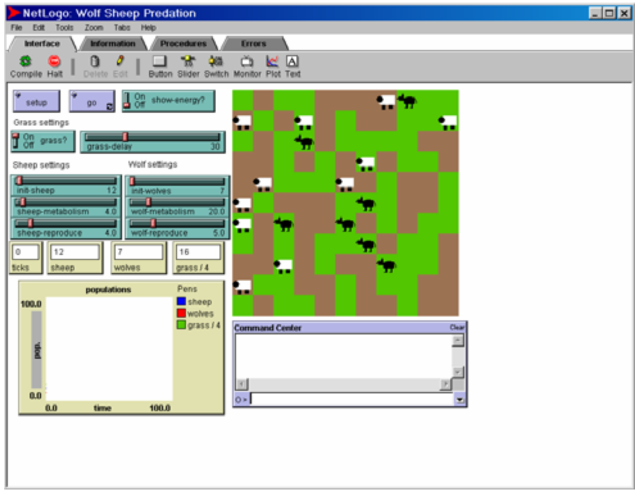
- to run almost any type of computer.
- problems with older, less powerful systems or older versions of system Software.
- If you have any trouble with NetLogo not working on your system, we would like to offer assistance.

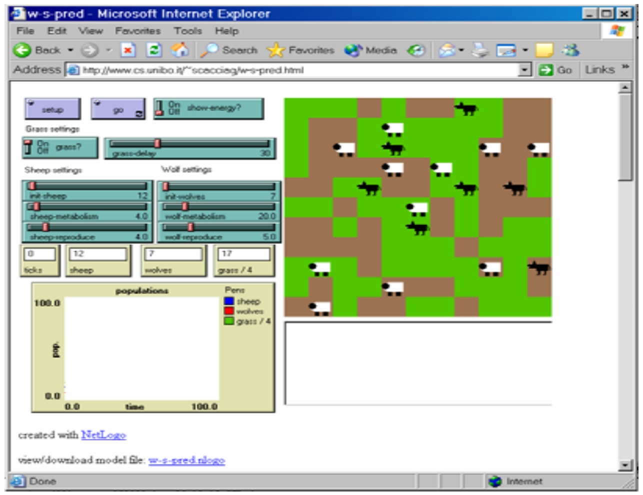
Please write **bugs@ccl.northwestern.edu.**

Application or Applet?

There are two ways to run NetLogo:

- **Download application**: this enables you to run NetLogo as a normal application.
- **Run applet** on the web within your browser window.





Features

- **Running** on the web is convenient,
- but **downloading** the application has some significant advantages:
  - Fewer compatibility issues with various operating systems and browsers.
  - Starts up faster.
  - Models run faster.
  - Window is resizable.
  - Edit menu is available.
  - Keyboard shortcuts for menu items are available.

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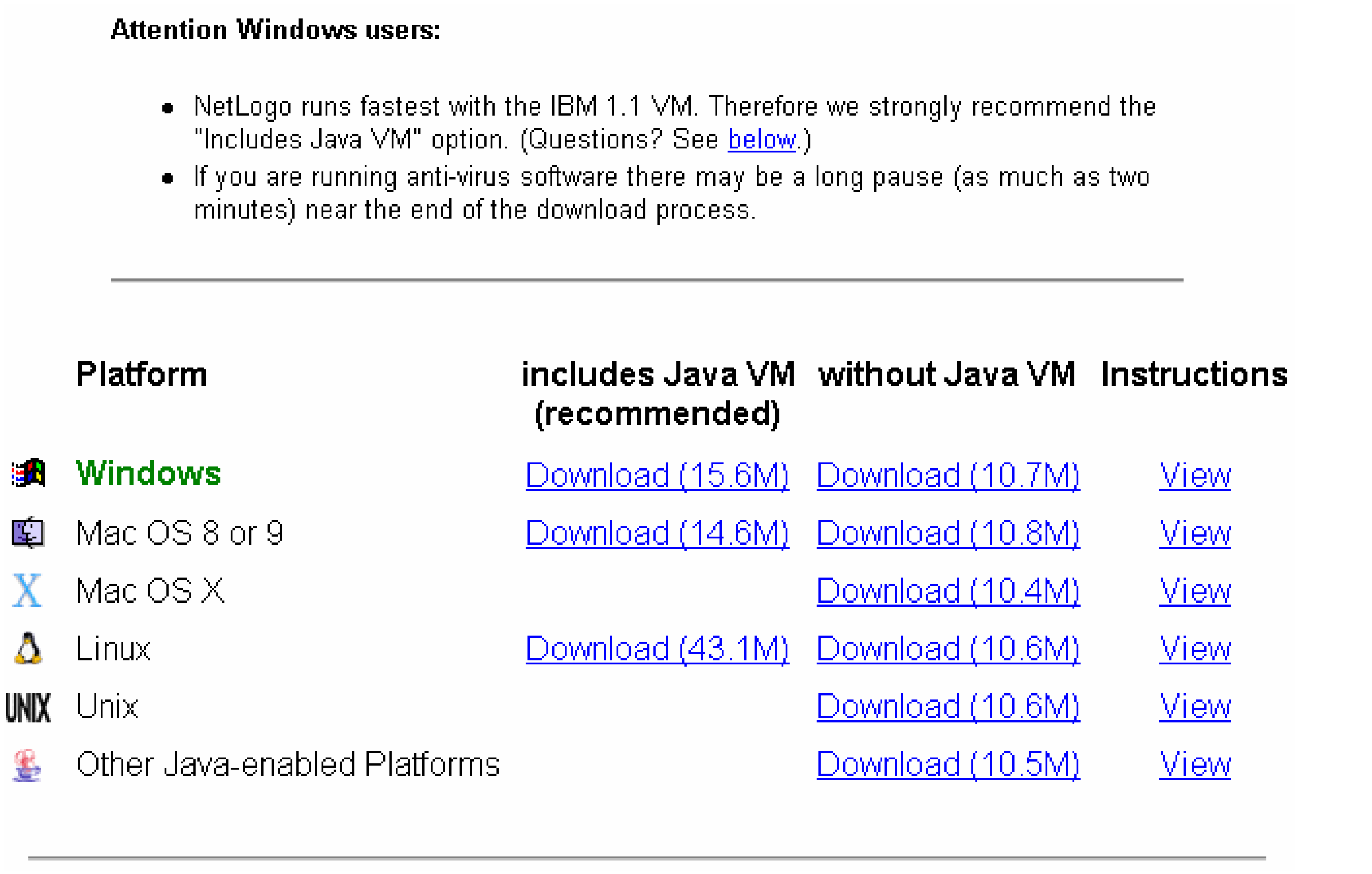
NetLogo Downloads



Attention Windows users:

- NetLogo runs fastest with the IBM 1.1 VM. Therefore we strongly recommend the "Includes Java VM" option. (Questions? See below.)
- If you are running anti-virus software there may be a long pause (as much as two minutes) near the end of the download process.

Platform	includes Java VM (recommended)	without Java VM	Instructions
Windows	Download (15.6M)	Download (10.7M)	View
Mac OS 8 or 9	Download (14.6M)	Download (10.8M)	View
Mac OS X		Download (10.4M)	View
Linux	Download (43.1M)	Download (10.6M)	View
Unix		Download (10.6M)	View
Other Java-enabled Platforms		Download (10.5M)	View

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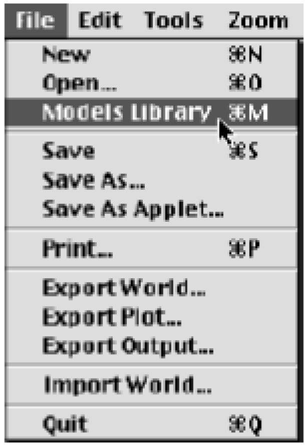
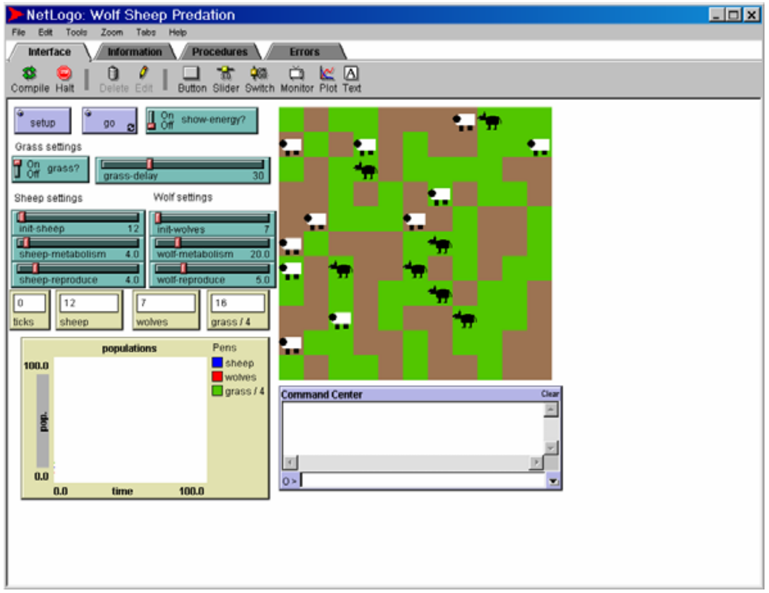
Sample Model: Wolf Sheep Predation

In this Model, you open and run models:

- pressing buttons,
- changing slider
- and switch values,
- and gathering

information from a model using plots and monitors.

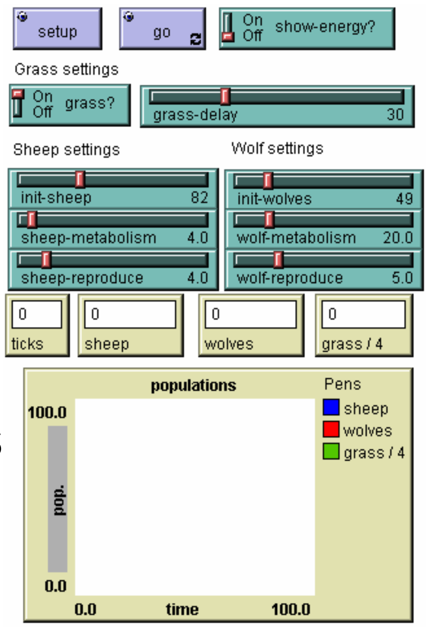



NetLogo: Wolf Sheep Predation
File Edit Tools Zoom Tabs Help
Interface Information Procedures Errors
Compile Halt Delete Edit Button Slider Switch Monitor Plot Text
setup
go
Grass settings
Sheep settings
Wolf settings
populations
Pens
🟦 sheep
🟥 wolves
🟩 grass / 4
pop.
time
Command Center
Clear
O>

show-energy? Off
grass? Off
grass-delay 30
init-sheep 12
sheep-metabolism 4.0
sheep-reproduce 4.0
init-wolves 7
wolf-metabolism 20.0
wolf-reproduce 5.0
ticks 0
sheep 12
wolves 7
grass / 4 16
100.0 0.0 0.0 100.0

Interface Tab

- The **Interface tab** will fill up with lots of buttons, switches, sliders and monitors.



show-energy? Off

grass? On

grass-delay 30

init-sheep 82

sheep-metabolism 4.0

sheep-reproduce 4.0

init-wolves 49

wolf-metabolism 20.0

wolf-reproduce 5.0

ticks 0

sheep 0

wolves 0

grass / 4 0

🟦 sheep
🟥 wolves
🟩 grass / 4

These interface elements allow you to interact with the Model:

- **Buttons** set up, start, and stop the model.
- **Sliders** and **Switches** alter model settings
- **Monitors** and **Plots** display data.

- you can use the zoom menu at the top of the window.
- To begin the model, you will first need to set it up.

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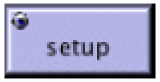
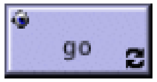
Controlling the Model: Buttons

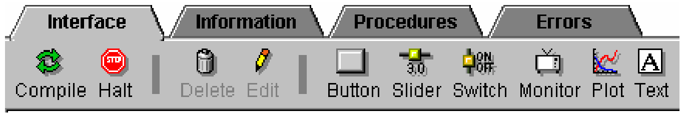
- When a button is pressed, the model responds with an action.
  - **Once** buttons do one action and then stop. When the action is finished, the button pops back up.



  - **Forever** buttons do an action over and over again. When you want the action to stop, press the button again. It will finish the current action, then pop back up.

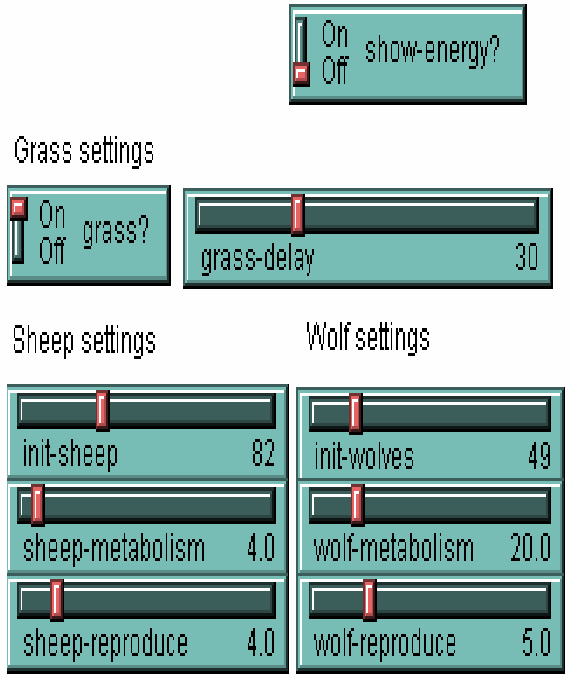


- Most models have a once button called "**setup**" and a forever button called "**go**". Many models also have a once button called "**go once**" or "**step once**"
- You can also stop a model with the "**Halt**" button on the Interface toolbar.
  - The "**Halt**" button may interrupt the model in the middle of an action, and as the result the model could get confused.



Adjusting Settings: Sliders and Switches

- The settings within a model give you an opportunity to work out different scenarios or hypotheses.
- Altering the settings and then running the model to see how it reacts to those changes can give you a deeper understanding of the phenomena being modeled.
- **Switches** and **sliders** give you access to a model's settings.


On Off show-energy?

Grass settings

On Off grass?

grass-delay 30

Sheep settings

init-sheep 82

sheep-metabolism 4.0

sheep-reproduce 4.0

Wolf settings

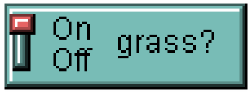
init-wolves 49

wolf-metabolism 20.0

wolf-reproduce 5.0

Switches

- Switches are set up in an **on/off** format.
- Switches turn on/off a separate set of directions.
- These directions are usually not necessary for the model to run, but might add another dimension to the model.
- Turning the "grass?" switch on affected the outcome of the model.
  - Prior to this run, the growth of the grass stayed constant. This is not a realistic look at the predator-prey relationship; so by setting and turning on a grass growth rate, we were able to model all three factors: sheep, wolf and grass populations.



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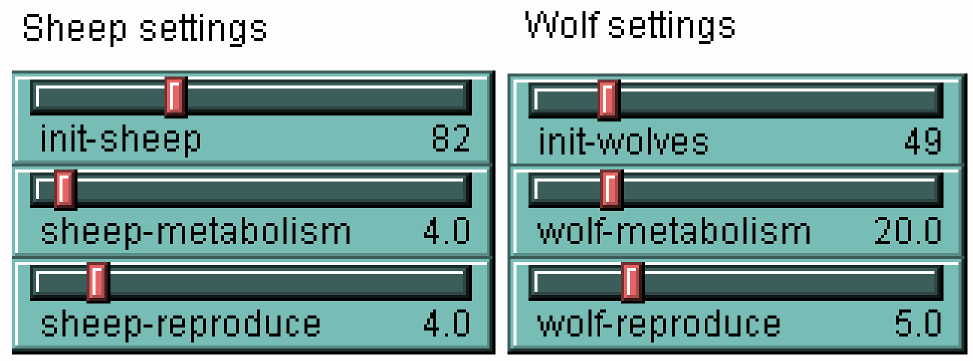
Sliders

- A slider has a **range** of numeric values that can be adjusted.
- As you move the marker from the **minimum** to the **maximum** value, the number on the right side of the slider is currently set to.



Sheep settings

init-sheep 82

sheep-metabolism 4.0

sheep-reproduce 4.0

Wolf settings

init-wolves 49

wolf-metabolism 20.0

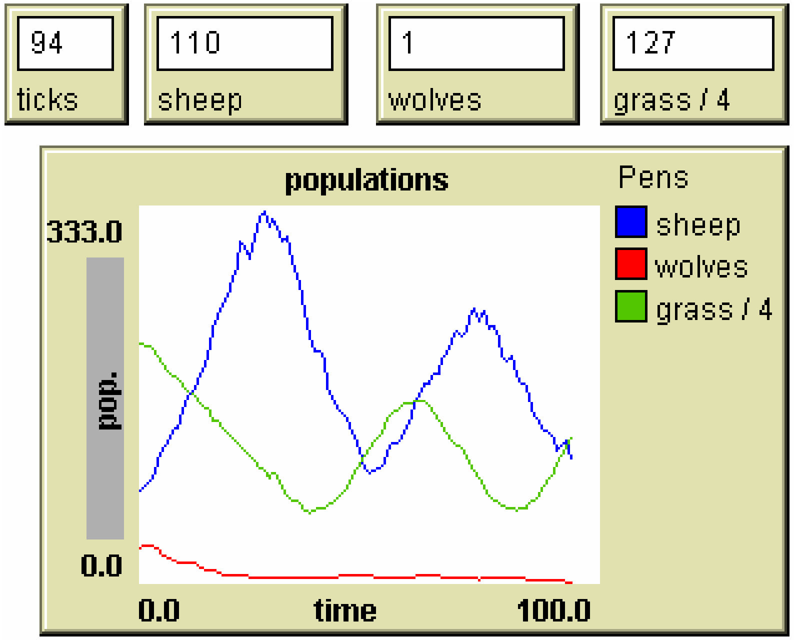
wolf-reproduce 5.0

- For example, the "initial-sheep" slider has a minimum value of 0 and a maximum value of 250. The model could run with 0 sheep or it could run with 250 sheep, or anywhere in between. Try this out and see what happens.

Gathering Information: Plots and Monitors

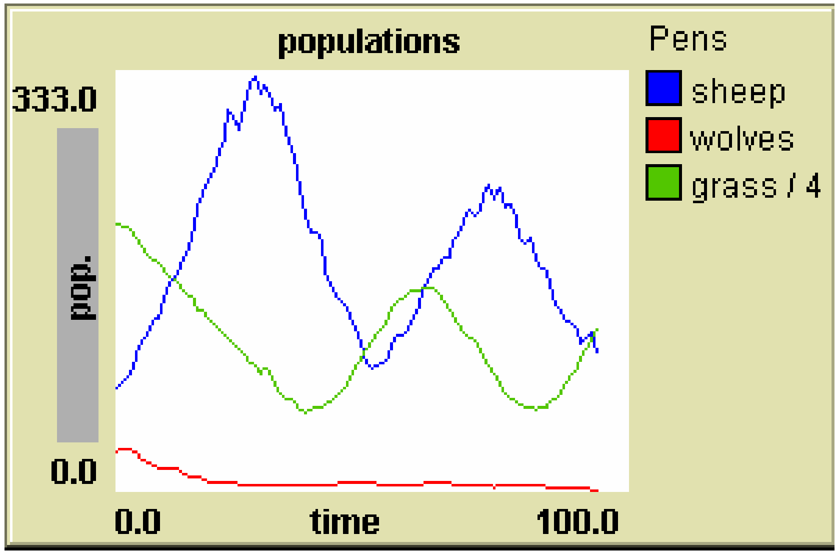
- A purpose to modeling is to gather data on a subject or topic that would be very difficult to do in a laboratory situation.
- NetLogo has two main ways of displaying data to the user:

  plots and **monitors**.



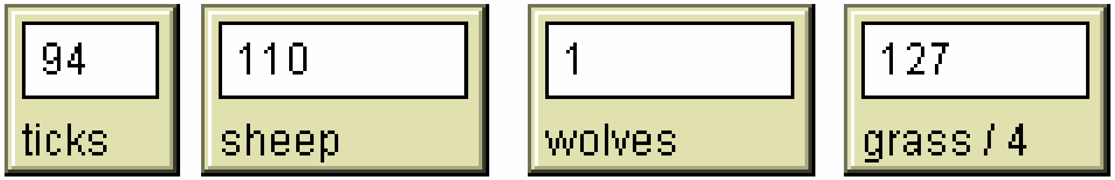
Plots

- The **lines** show what's happening in the model over time.
- To see which line is which, click on "**Pens**" in the upper right corner of the plot window to open the plot pens legend.
- To view or analyze the data from a plot in another program, you can use the "**Export Plot**" item on the File menu.



Monitors

- The monitor labeled "**time-ticks**" tells us how much time has passed in the model.
- The other monitors show us the population of sheep and wolves, and the amount of grass.
- The numbers displayed in the monitors update continuously as the model runs.



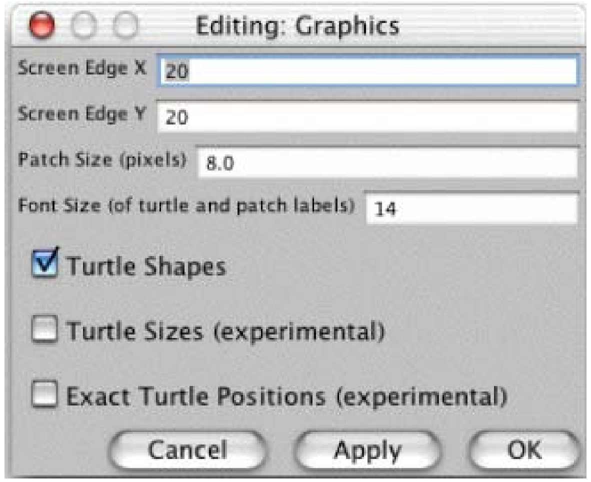
Changing Graphics Window Settings

The size of the Graphics Window is determined by three separate settings:

Screen Edge X,

Screen Edge Y,

and **Patch Size**.


Editing: Graphics

Screen Edge X: 20

Screen Edge Y: 20

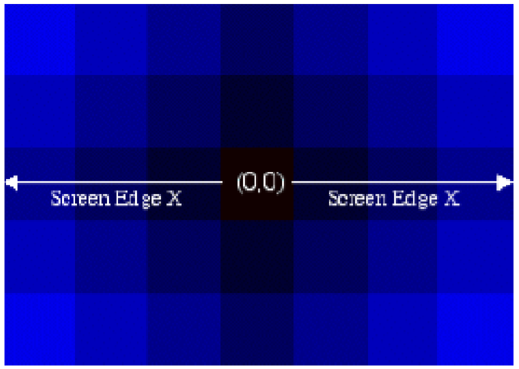
Patch Size (pixels): 8.0

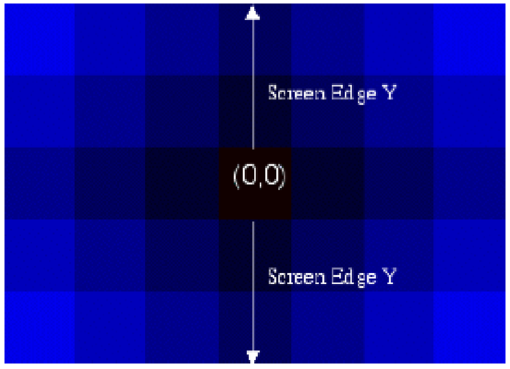
Font Size (of turtle and patch labels): 14

[✓] Turtle Shapes

[ ] Turtle Sizes (experimental)

[ ] Exact Turtle Positions (experimental)





The Models Library

The Library contains **four** sections:

- **Sample Models**

  The Sample Models section is organized by subject area.
- **Code Examples**

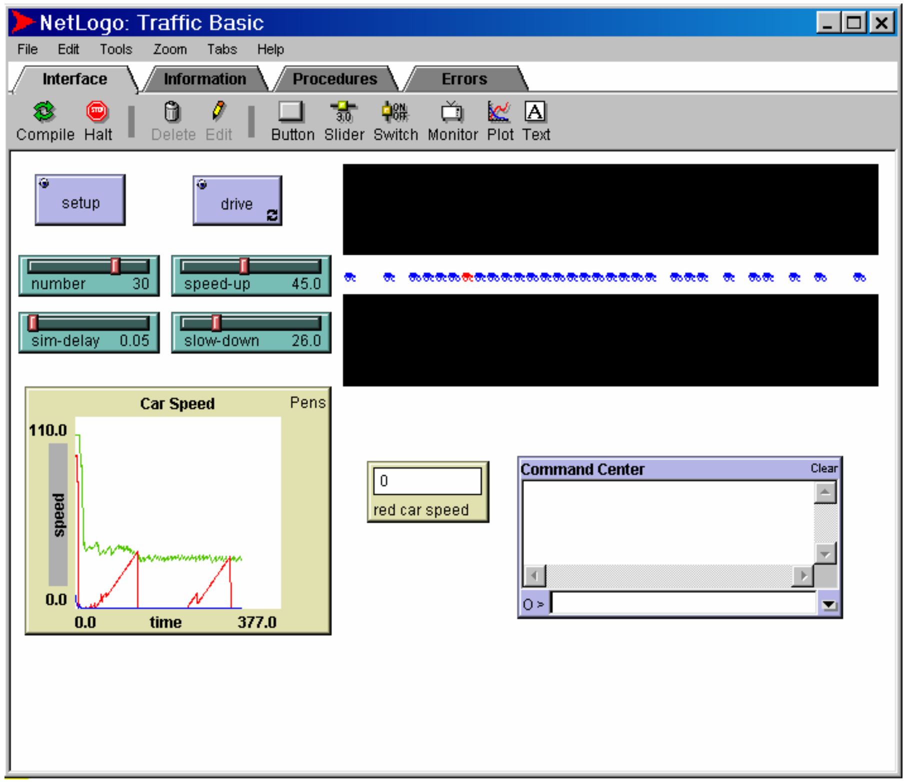
  These are simple demonstrations of particular features of NetLogo.
- **HubNet Activities**

  This section contains participatory simulations for use in the classroom.
- **Unverified Models**

  These models are still in the process of being tested and reviewed for content and accuracy.

Sample Model: Traffic Basic

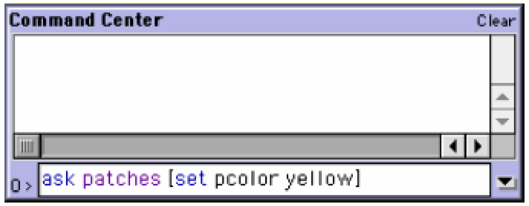
In this Model, the focus will start to shift from observing models to manipulating models.

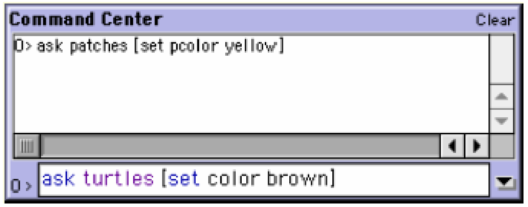


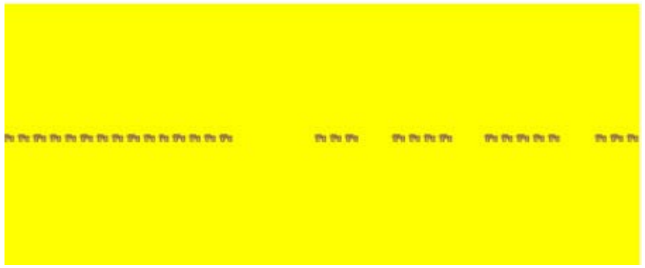
The Command Center

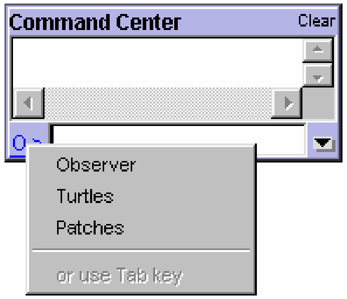
- The Command Center allows you to enter **commands** or **directions** to the model.
- Commands are **instructions** you can give to:

  turtles, patches, and the observer.

1


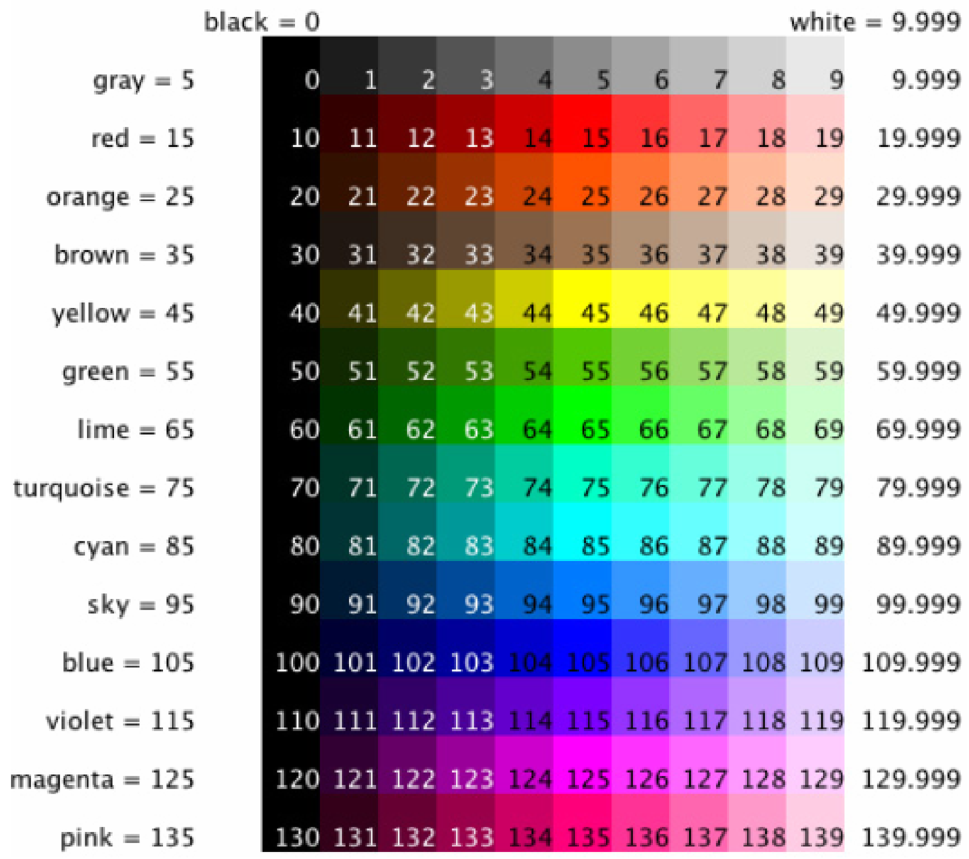
2

Command Center
Clear
O> ask patches [set pcolor yellow]
O>
ask turtles [set color brown]

3


4


Working With Colors

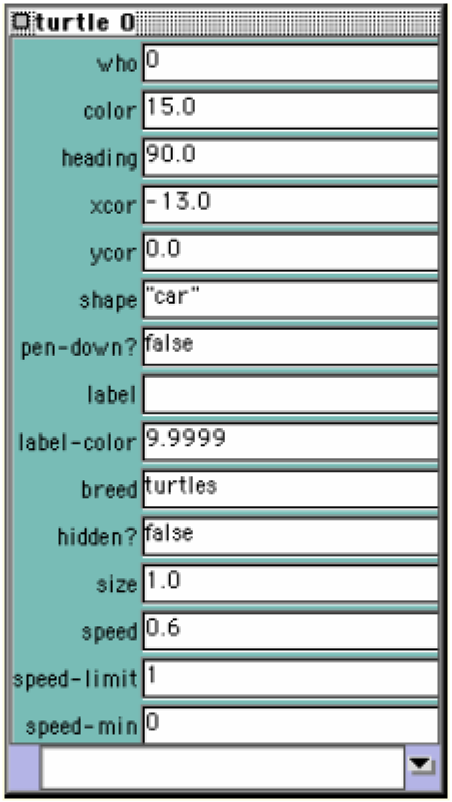
- In NetLogo, all colors have a **numeric** value.
- In all of the exercises we have been using the **name** of the color (**16).**



	black = 0										white = 9.999
gray = 5	0	1	2	3	4	5	6	7	8	9	9.999
red = 15	10	11	12	13	14	15	16	17	18	19	19.999
orange = 25	20	21	22	23	24	25	26	27	28	29	29.999
brown = 35	30	31	32	33	34	35	36	37	38	39	39.999
yellow = 45	40	41	42	43	44	45	46	47	48	49	49.999
green = 55	50	51	52	53	54	55	56	57	58	59	59.999
lime = 65	60	61	62	63	64	65	66	67	68	69	69.999
turquoise = 75	70	71	72	73	74	75	76	77	78	79	79.999
cyan = 85	80	81	82	83	84	85	86	87	88	89	89.999
sky = 95	90	91	92	93	94	95	96	97	98	99	99.999
blue = 105	100	101	102	103	104	105	106	107	108	109	109.999
violet = 115	110	111	112	113	114	115	116	117	118	119	119.999
magenta = 125	120	121	122	123	124	125	126	127	128	129	129.999
pink = 135	130	131	132	133	134	135	136	137	138	139	139.999

Agent Monitors

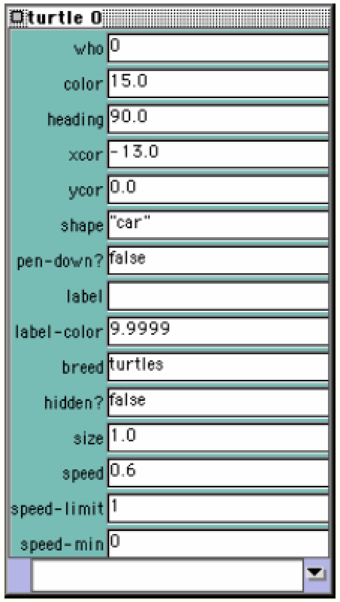
- We used the set command to change the colors of **all** the cars.
- Let's look at how to change only **one** car's color.
- Click on the red car with the right mouse button.
- From the popup menu, choose "**inspect** turtle 0"
- We can see all of the **variables** of the red car.
- The value of variable can be **changed**.


turtle 0

who	0
color	15.0
heading	90.0
xcor	-13.0
ycor	0.0
shape	"car"
pen-down?	false
label	
label-color	9.9999
breed	turtles
hidden?	false
size	1.0
speed	0.6
speed-limit	1
speed-min	0

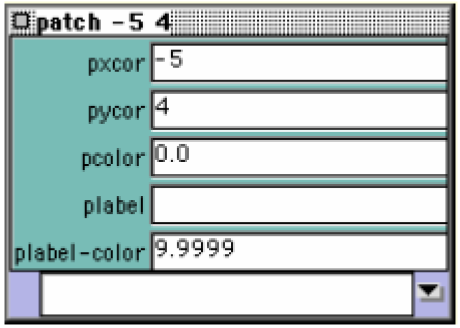
Agent Commanders

- An **Agent Commander** found at the bottom of an Agent Monitor.
- You type commands here, just like in the Command Center, but the commands you type here are only done by **this particular turtle**.
- Idem for Patches



turtle 0

who	0
color	15.0
heading	90.0
xcor	-13.0
ycor	0.0
shape	"car"
pen-down?	false
label	
label-color	9.9999
breed	turtles
hidden?	false
size	1.0
speed	0.6
speed-limit	1
speed-min	0



patch -5 4

pxcor	-5
pycor	4
pcolor	0.0
plabel	
plabel-color	9.9999

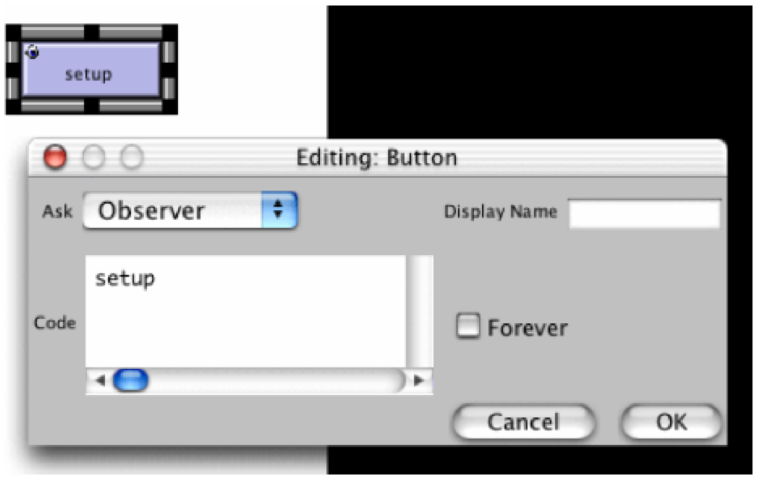
Procedures

The heart of a NetLogo Model is the **Procedures tab**.

- Keep in mind how people usually think of these three different kinds of agents:
  - The turtles and patches mostly use information about what's **close** to them.
  - The observer typically uses and accesses the **whole** world.
- While patches can't move and often represent some sort of environment, turtles can move around in the world.

Setup and Go

- To start a new model, select "**New**" from the File menu.
- Then create a once-button called 'setup'.
- Now you have a button called 'setup'. It will execute the procedure 'setup' when pressed,
- set up the NetLogo world.



Ask: Observer

Code: setup

☐ Forever

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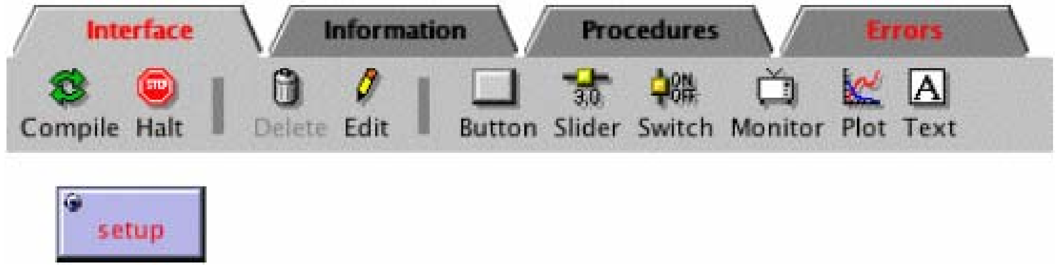
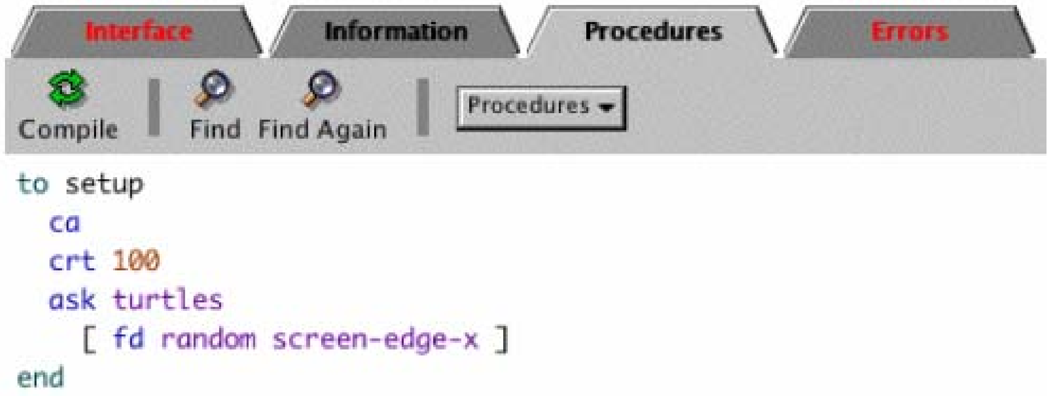
Setup



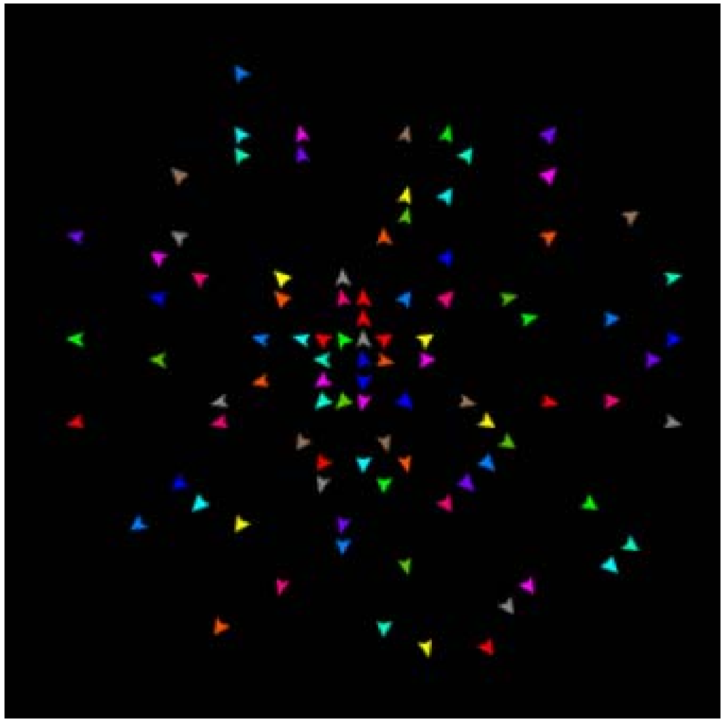
- Now switch to the Procedures Tab and create the 'setup' procedure shown below.



```
to setup
  ca
  crt 100
  ask turtles
    [ fd random screen-edge-x ]
end
```

Press your 'setup'

- Press your 'setup' button when you're done writing the code.



Go

- Make a forever-button called '**go**'. Again, begin by creating a button, but this time check the "**forever**" checkbox in the edit window.

```
to go
    move-turtles
end

to move-turtles
    ask turtles [
        set heading (random 360)
        fd 1
    ]
end
```

Patches and Variables

Now you've got 100 turtles **aimlessly** moving around, completely unaware of anything else around them. Let's give these turtles a nice background against which to move:

```
patches-own [elevation]
to setup
    ca
    setup-patches
    setup-turtles
end
```

Patches and Variables

```
to setup-patches
    ask patches
    [ set elevation (random 10000) ]
    diffuse elevation 1
    ask patches
    [ set pcolor scale-color green elevation 1000 9000 ]
end

to setup-turtles
    crt 100
    ask turtles
    [ fd (random screen-edge-x) ]
end
```

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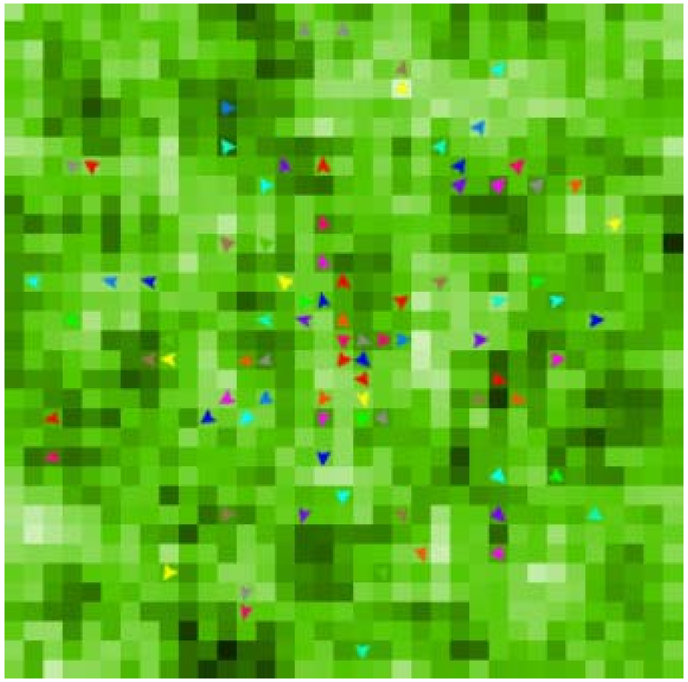
Landscape

- Press the '**setup**' button back in the model's interface.
- Voila! A lush NetLogo **landscape** complete with turtles and patches appears.



Globals

```
globals [highest lowest] ;; highest and lowest patch elevation

to setup-patches
    ask patches [ set elevation (random 10000) ]
    diffuse elevation 1
    ask patches
    [ set pcolor scale-color green elevation 1000 9000 ]
    set highest max values-from patches [elevation]
    set lowest min values-from patches [elevation]
    ask patches [
          if (elevation > (highest - 100))
                    [set pcolor white]
          if (elevation <(lowest + 100))
                    [set pcolor black] ]
end
```

Simple Algorithm

```
to move-turtles
        ask turtles
        [       set heading (random 360)
                fd 1]
end
```

- the turtles <u>cannot see ahead</u> farther than just one patch;
- each turtle can move only <u>one square</u> each turn;
- turtles are <u>blissfully</u> ignorant of each other.

An Uphill Algorithm

```
;; each turtle goes to the highest elevation in a radius of one
to move-to-local-max
    ask turtles
    [        set heading uphill elevation
             if ( elevation-of patch-at dx dy > elevation )
             [ fd 1 ]]
end
```

- If none of the patches around it have a higher elevation than the patch it is on, it'll stay put.
- Our turtles rapidly arrive at local maxima in our landscape.

An Uphill Algorithm

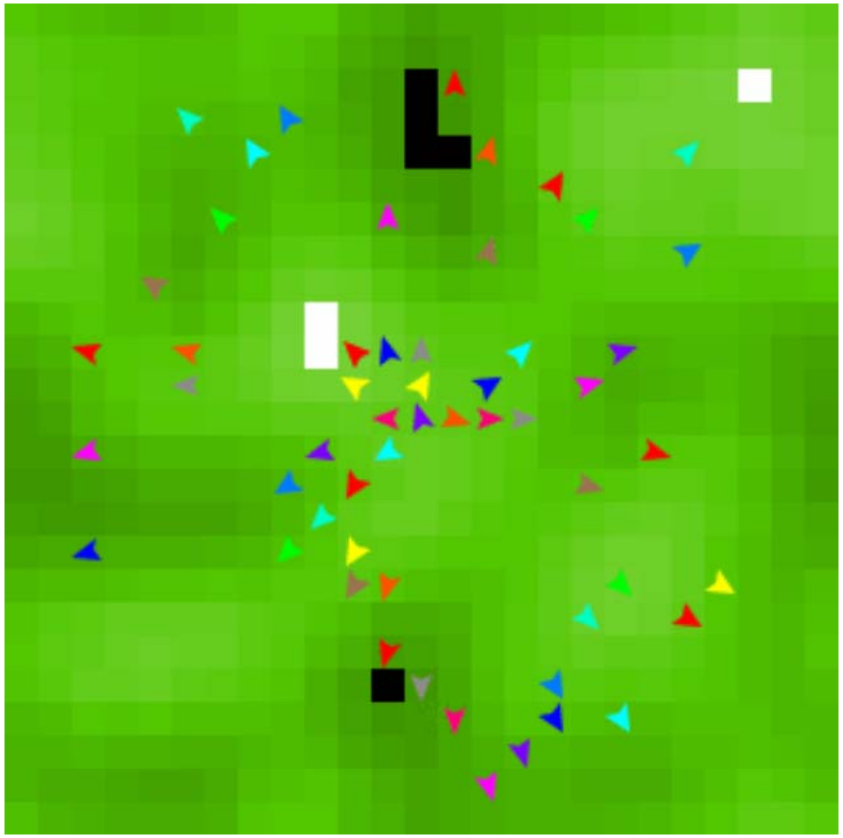
- Our goal is to still get the turtles to find an **'optimal maximum'**, which is one of the white patches.

```
to recolor-patches
    ask patches
    [         set elevation pycor
              set pcolor scale-color green elevation
                        (0 - screen-edge-y) screen-edge-y]
end
```

After Replace the line: diffuse elevation 1

with repeat 5 [diffuse elevation 1]

An Uphill Algorithm



Plot

- NetLogo allows us to plot data as we go along.
- To make plotting work, we'll need to **create** a plot in the Interface tab, and set some settings in it.
- Then we'll add one more procedure to the Procedures tab, which will **update** the plot for us.

```
to do-plots
    set-current-plot "Turtles at Peaks"
    plot count turtles with
            [ elevation >= (highest - 100) ]
end
```

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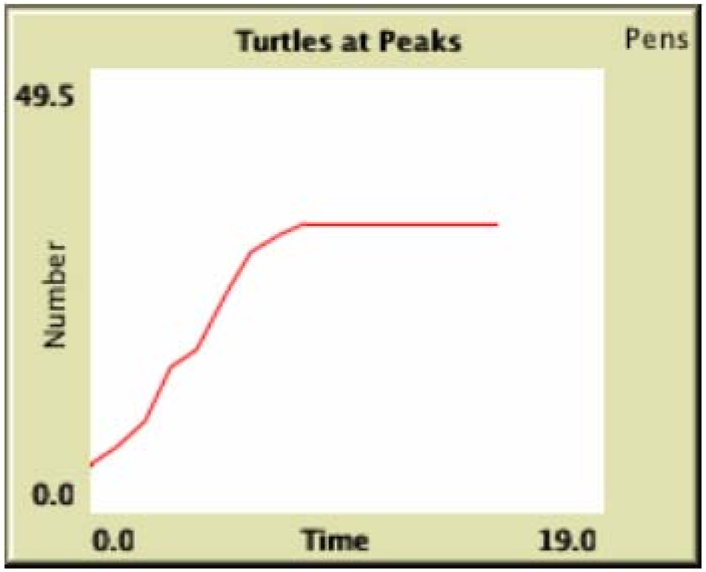
Plot

- The **plot** primitive adds the next point to a plot.
- we need to tell NetLogo **which plot** we want update.



HubNet

- HubNet is a technology that lets you use NetLogo to run **participatory simulations** in the classroom.
- In a participatory simulation, a whole class takes part in enacting the behavior of a system as each student controls a part of the system by using an individual device, such as a TI-83+ calculator or a networked computer.
- For example, in the Gridlock simulation, each student controls a traffic light in a simulated city.

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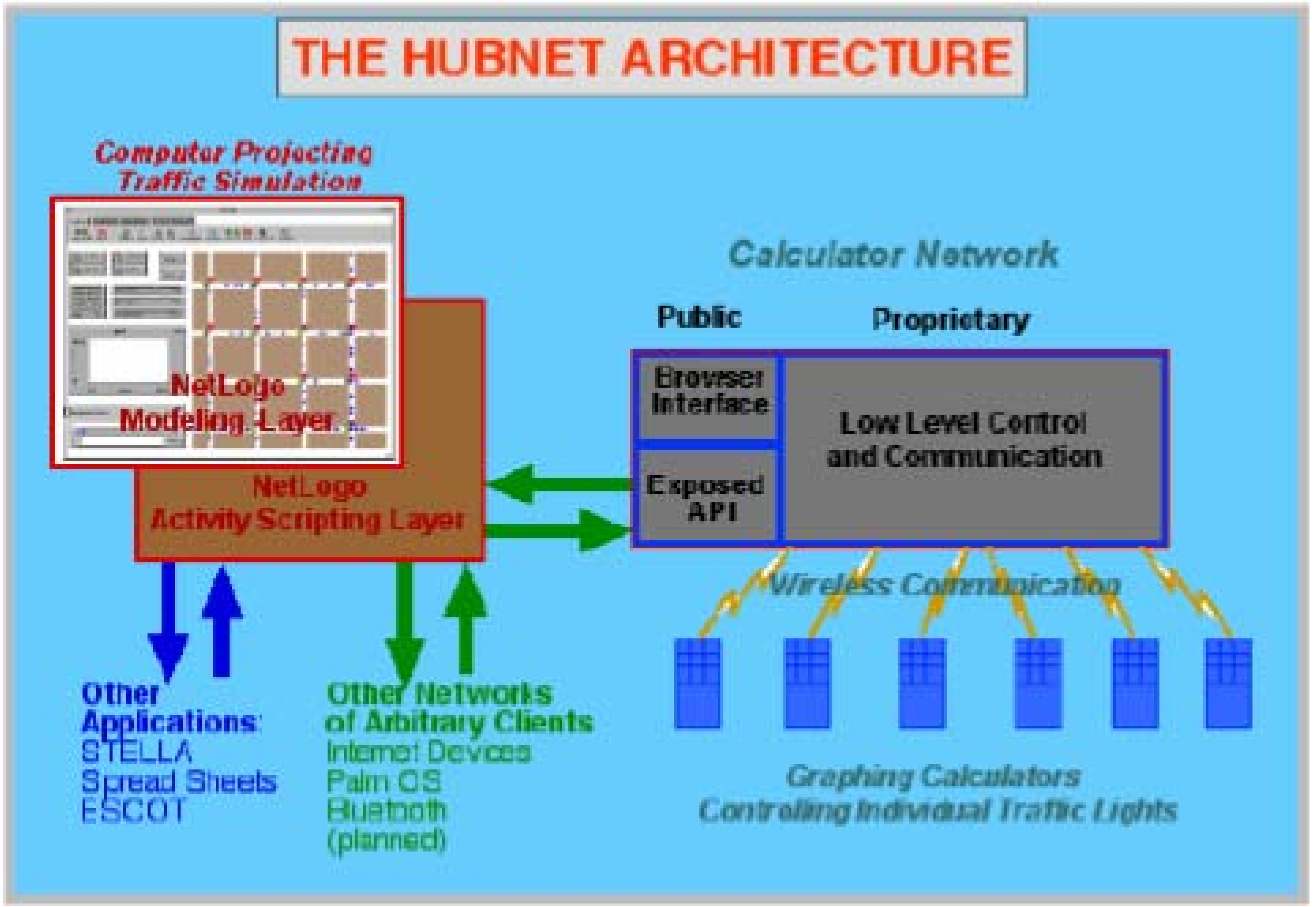
HubNet


THE HUBNET ARCHITECTURE
Computer Projecting Traffic Simulation
NetLogo Modeling Layer
NetLogo Activity Scripting Layer
Calculator Network
Public
Proprietary
Browser Interface
Exposed API
Low Level Control and Communication
Wireless Communication
Other Applications: STELLA Spread Sheets ESCOT
Other Networks of Arbitrary Clients Internet Devices Palm OS Bluetooth (planned)
Graphing Calculators Controlling Individual Traffic Lights

BehaviorSpace

- BehaviorSpace is a software tool integrated with NetLogo that allows you to perform experiments with models.
- It systematically varying the values of sliders and records the results of each corresponding model run.
- This way you can explore the model's "**space**" of possible behaviors and determine which combinations of slider values cause the behaviors of interest.

References

In the Netlogo site you can find:

- the last version of Netlogo
- the Netlogo User Manual
- the new Netlogo model
- and a group-discussion about Netlogo

http://www.ccl.sesp.northwestern.edu/netlogo/